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Examining the Validity of Traditional Risky Flight Behavioral Measures Across a Variety of Risky Flying Activities

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EXAMINING THE VALIDITY OF TRADITIONAL RISKY FLIGHT BEHAVIORAL MEASURES ACROSS A VARIETY OF RISKY FLYING ACTIVITIES

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Predicting pilots' willingness to engage in a variety of risky activities has implications for the selection and training of pilots (Drinkwater & Molesworth, 2010). In addition to traditional predictors of safety such as flight experience and age, a variety of measures have been employed that examine pilots' attitudes and risk perceptions (Hunter, 2002). However, in order to test their predictive validity, they are often paired with a single behavioral measure, nominally a simulated flight with a stable level of risk, potentially limiting their ability to predict pilots' risk management behavior accurately. Therefore, the aim of the present study was to examine the stability of these predictors across a variety of risky flying activities. The results revealed risk perception to be the only reliable predictor of pilots' risk management behavior, suggesting that the traditional measures of risky flight behavior may require revision to ensure their efficacy.

Predicting pilots' willingness to engage in a variety of risky activities has implications for the selection and training of pilots (Drinkwater & Molesworth, 2010). In the literature, attitude (Cox & Cox, 1991; Lund, & Rundmo, 2009; Hunter, 2005; Molesworth & Chang, 2009), age (Vroom & Pahl, 1971; Retting et al., 1999), risk perception (Hunter, 2006), and risk tolerance (Hunter, 2002) are samples of the variety of factors that have been linked to risky behavior.

It is thought that risk perceptions, attitudes, and experience influence risk-taking behavior in aviation (Molesworth & Chang, 2009). Indeed, previous research has identified both risk perception (Hunter, 2006; Molesworth & Chang, 2009) and attitude (attitude towards safe flight operation - Hunter, 2005; and attitude towards low altitude flight - Molesworth & Chang, 2009) as predictors of pilots' risky flight behavior. It is generally thought that attitudes affect behavior in the intuitive, or 'positive' direction, that is, a more conservative attitude would lead to a more conservative behavior, and a less conservative attitude, to a less conservative (or riskier) behavior. This expectation arises primarily from the Theory of Planned Behavior (see for example, Ajzen, 1991; Ajzen & Fishbein, 2005; Armitage & Conner, 2001).

In a similar fashion, in line with hypotheses previously put forward in the risk perception literature (see Brewer, Weinstein, Cuite, & Herrington Jr., 2004), risk perception is expected to affect behavior in line with its strength and direction. That is, if one perceives a risk to their safety (or other valuable asset), then it is expected that the individual will modify their behavior to minimise risk.

An underlying assumption with the research in this area, particularly within the general aviation research is that predictors of risky flight behavior are stable across a variety of risky situations. However, this assumption remains untested. Therefore, the aim of the present research was to examine whether the predictors of risky flight behavior are stable across a range of flights from low to high risk. This involved examining the relationship between attitudes, risk perceptions and experiential variables (i.e., age, flight experience, and recent flight time) of Australian General Aviation (GA) pilots and their self-reported behavior. Specifically, the following research was designed to answer the following two questions

Research Questions

1. What is the relationship between the attitudes, risk perception, experiential factors and the behavior of pilots in the general aviation?

2. Are known predictors of risky flight behavior in general aviation contextually sensitive?

Experimental design

The study consisted of a single session, in which participants completed a battery of pen-and-paper surveys. The study was designed to examine the relationship between attitudes towards aviation safety (using Hunter's ASAS, see Hunter, 1995), risk perceptions of aviation-centric situations (using Hunter's Risk Perception Scales 1 and 2, see Hunter, 2005), experiential variables (e.g., age, and flying experience in terms of flight hours), self-reported risk ratings and self-reported risky flight behavior. Self-reported behavior and the reported risk ratings were gathered for three hypothetical flight scenarios. The three scenarios as described below were selected from a total of nine by seven Subject Matter Experts - SMEs (i.e., senior instructors in general aviation). Specifically, SMEs were asked to rate the level of risk in each scenario, with the anchor points being 0 – no risk and 100 – high risk, with the likelihood of death being high. Based on mean ratings, three scenarios were selected at three points on the risk rating, namely low, medium and high. However, prior to determining these scenarios it was important to ensure SME rated the scenarios similarly. The results of inter-rater agreement analysis utilising an intra-class correlation coefficient illustrated good agreement between the raters with respect to the ratings given to the scenarios, $R(6) = .875$.

The scenarios used in this experiment were the ''Hunter Valley'' Scenario, the "Ferry to LAME" scenario, and the "Moruya" Scenario.

The first scenario, rated as the lowest risk by the expert group was the "Hunter Valley" scenario. In this scenario, pilots were told that they had planned a flight from Camden to Cessnock (approximately 1 hour flight time) in fine weather, with no time pressures. There were appropriate back-up plans in case the weather turned bad or the aircraft was not performing suitably.

The second scenario presented, which was rated as medium risk by the expert group was the "Ferry to LAME" scenario, in which pilots were being asked to ferry their friend's aircraft to an airport approximately one hour away in order that maintenance be performed. The aircraft was very near to its allowable flight time before maintenance was required by regulations, there was poor weather fast approaching the destination airport, and the en-route weather was such that the cloud base was at 1,000 feet above ground level. Therefore, the pilot was under pressure to 'beat' the weather and fly lower than normal in order to get the aircraft to its maintenance appointment.

The final scenario, rated as high risk by the expert group was the "Moruya" scenario. In this scenario participants were asked to fly an aircraft with critically low fuel (23 minutes of fuel remaining, including reserves) to search for a skydiver that had landed away from the normal landing zone for the local skydivers. Whilst not required of the pilots explicitly, search operations may necessitate low flight which would be an additional hazard.

The three distinct levels of risk were used in the experiment for two reasons. The first was to examine pilots' different behavioral responses to the three risk scenarios, while the second was to examine if predictors of these behavioral responses varied depending on the level of risk in each scenario (i.e., low, medium and high-risk). The design also allowed the scenarios presented to pilots to be multi-dimensional with regards to the number and type of risks present. This is as opposed to utilising a uni-dimensional design, in which a single risk is present as is the norm in the literature (see Goh & Wiegmann, 2001; Molesworth, Wiggins, & O'Hare, 2006; O'Hare & Smitheram, 1995). The desired advantage of utilising scenarios that feature multi-dimensional risk is that this more closely resembles the operational environment as hazards are rarely found in isolation. It is hoped that the findings of a study that is grounded in more realistic assumptions and scenarios may be more representative of the situation with regards to the predictors of risk management behavior in the industry.

The flight scenarios were designed such that pilots had the ability to choose and report their actions, rather than only rating the relative risk of the scenario on a scale of 1 to 100, as in Hunter's risk perception scales. In this way, the experiment was designed to be more like a flight simulation than a risk-rating survey as pilots were asked to make the same decisions as they would be forced to make in a simulation (or real aircraft), but they are not asked to undertake the physical act of operating the aircraft.

Since the main aim of the study was to determine if pilots would undertake such flights, the dependent variable under examination was pilots decision to 'Go' (choosing to undertake the flight) or 'No-Go' (choosing not to undertaken the flight). This is opposed to the options available for a flight simulator based experiment in which continuous variables such as total time flown, altitude flown, or speeds reached could be utilised.

Method

Participants

Thirty-eight participants were recruited from flying schools and institutions located in the greater Sydney Basin, NSW Australia. The mean age of the participants was 27.03 years (SD = 14.90), the mean flight experience was 599.16 hours (SD = 2102.67) and the mean total of hours in the past 90 days was 28.56 (SD = 32.95 hours).

Materials and Stimuli

The material consisted of: a demographics questionnaire, ASAS questionnaire (Hunter, 1995), Risk Perception 1 and 2 questionnaires (Hunter, 2002), followed by the three flight scenarios. The completed surveys were collected from the participants directly. All data gathered was entered into SPSS v. 13 for Macintosh. The material and all stimuli were approved in advance from the University of New South Wales Ethics Panel.

Procedure

Participants were informed about the research through two methods: a personal brief given by the researcher and/or an advertisement poster placed on trainee organisations' notice boards. Participants interested in completing the survey required for the research arranged a mutually suitable time in which to undertake the work. Participants were asked to complete the five questionnaires in the following order, the demographic survey, Hunter's Risk perception scale 1 and 2, Hunter's ASAS, and finally the flight scenarios. At the conclusion of the study participants were thanked for their time.

Results

Data Analysis

The main objective of the experiment was to determine the relationship between pilot demographic measures, attitudes, risk perceptions, and the self-reported behavior of pilots. In order to investigate this, a series of Spearman's ρ correlations were employed. This test was used as the self-report behavioral data was nominal data. With alpha set at .05, a series of correlational analyses revealed only four relationships, all within the medium risk scenario (the Ferry to LAME scenario). Specifically, a positive relationship was found between the decision to go and the risk perception factors of Delayed Risk $r(38) = 0.36$, $p = .03$, General Flight Risk $r(38) = 0.33$, $p = .04$, High Risk $r(38) = 0.41$, $p = .01$, and Altitude Risk $r(38) = 0.41$, $p = .01$. No other relationships were noted, (largest $r = -.29$, $p = .08$). The positive direction of these relationships indicate that the pilots that chose to go (coded as one in the analysis) displayed a lower level of risk perception on these factors than did those pilots that elected not to fly (coded as two; see Table 1.).

Two pilots chose not to complete the Hunter Valley scenario (low risk flight), while thirty-five pilots chose not to complete the Ferry to LAME flight (medium risk) and the Moruya flight (high risk).

Table 1.

Correlations Between Behavior and Risk Perception, Attitude & Experiential Variables

Scenario (Expert Risk Level)	Age	Total Hours	Recent Hours	Delayed Risk	Nominal Risk	Immediate High Risk	General Flight Risk	High Risk	Altitude Risk	Driving Risk	Everyday Risk	Self Confidence	Risk Orientation	Safety Orientation
Hunter (Low)	.08	-.17	-.24	.11	.22	-.15	-.08	-.02	.06	-.09	-.05	-.12	.23	-.10
Ferry (Medium)	.04	-.11	-.23	.36*	.24	.28	.33*.	41*	.44**	.07	.14	-.04	-.07	-.10
Moruya (High)	.09	-.18	-.11	.17	-.07	-.05	-.03	.00	.01	.13	.18	-.29	.09	.04

* $p < 0.05$ ** $p < 0.01$

Discussion

The present study was designed to answer two main questions. The first was to examine the predictors of risky flight behavior in general aviation and the second was to examine the contextual sensitivity of these predictors. The results revealed that both attitudinal and experiential factors as measured in the present study were not related to the decision to fly. In terms of the former, this finding is relatively unique and differs from the majority of academic literature in the area of attitude and behavior (Ajzen, 1991; Albarracín, Fishbein, Johnson, & Muellerleile, 2001; Crano & Prislin, 2006; Deery, 1999; Glasman & Albarracín, 2006; Smith & Terry, 2003) in that most studies have found that attitude affects behavior to a greater extent than was evident in the current experiment.

There are many possible causes for this finding. The General Aviation industry in Australia exhibits what is arguably a healthy safety culture, in which safety is a cultural norm. Safety-based publications are distributed to all pilots, and safety management systems are utilised extensively by commercial (and private) operators. In contrast to this, other studies are often undertaken within systems similar to the road environment, where little or no testing, checking, or other safety-related activities like training are undertaken by authorities. An additional difference that may contribute is the self-selection bias caused by the cost and relatively rigorous academic, time and physical requirements of flight training, when compared to the relative economy and ease of driving, or other similarly ubiquitous activities.

In terms of the latter – experiential factors, the results revealed neither age nor experience appeared to be related to the decision to undertake (or not to undertake) any of the flight scenarios. An inference from the finding is that older pilots or more experienced pilots performed no better than their younger counterparts with regards to conservative behavior. This finding is dissimilar to those of the road safety arena, where increasing age has been linked to more conservative behavior (Deery, 1999). As above, there are many possible reasons for this finding, and indeed, all factors mentioned above are valid hypotheses as to the reasons why the current finding differed from those in the literature. With particular reference to the relationship between age and risk-taking, it may be the case in Australian GA that a self-selecting bias is present such that younger candidates are more risk averse than is the population wide norm. Therefore, it is possible that there is less of an initial difference in risk perception between younger and older pilots than there is between younger and older people in the populations, leading to the lack of correlation as found in the current research. This hypothesis however, has not been tested in the current research.

The finding that both total flight hours and recent flight hours are not related to behavior is echoed in the recent aviation literature, with studies in the Australian aviation environment finding that these two experiential factors appear unrelated to behavior (Molesworth & Chang, 2009).

It was found however, that the risk perception factors Delayed Risk, General Flight Risk, High Risk, and finally Altitude Risk were all related to behavior. That is, participants that exhibited a higher level of these risk perception factors were more likely to choose not to fly. This conforms to the accuracy hypothesis of risk perception (Brewer et al., 2004), in which the perception of a risk will lead to compensatory behavior by an individual as an attempt to reduce the amount of risk encountered and therefore perceived. This is also consistent with Hunter's (2006) findings, in which those with higher perceptions of risk were less likely to have experienced hazardous situations in comparison to those that rated the risks as lower.

The scenarios in the current research utilised multi-dimensional risk factors, such that there were at least two risk factors present for each scenario. It appears from the current results that the perception of risks in uni-dimensional risk scenarios (as in Hunter's Risk Perception scales) is related (albeit relatively weakly) to the perception of multi-dimensional risk. That is, risk perception of relatively simple situations seems to be related to risk perception in more complex (with regards to the hazards present) situations.

In relation to the second question, the results did reveal that the predictors of risky flight behavior are contextually sensitive. Moreover, in the present study only the medium risk scenario produced any statistically significant correlations. This is an important finding as it highlights the potential limitations of relying on the traditional predictors of risky behaviour to explain the diversity in all risky behavior. Considering high-risk situations present the greatest level of risk to safety, future research should investigate if there are more appropriate indicators or predictors to explain this often undesired behavior. This finding also points towards a possible limitation in previous research that has employed only a single scenario to measure the attitude/risk perception-behavior relationship. Conversely, the results of the present study may have been influenced by the experiment design, namely a pen and paper exercise opposed to a simulated flight or actual flight. This is another area for future research.

Conclusion

From the current study, it appears that attitude, age and experience do not significantly affect the risk management of pilots in Australian GA. Making sound risk management decisions, given the context, appears to be most dependent upon risk perception, not experiential or attitudinal factors. It was also identified that predictors of risky flight behavior are contextually sensitive. However, these conclusions are based on a pen and paper study and future research should be directed towards replicating these finding in the operational environment or at least within a flight simulator.

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References

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179-211.

Ajzen, I., & Fishbein, M. (2005). The Influence of Attitudes on Behavior. In D. Albarracín, B. T. Johnson & M. P. Zanna (Eds.), *The Handbook of Attitudes*. Mahwah, NJ: Erlbaum.

Albarracín, D., Fishbein, M., Johnson, B. T., & Muellerleile, P. A. (2001). Theories of Reasoned Action and Planned Behavior as Models of Condom Use: A Meta-Analysis. *Psychological Bulletin, 127*(1), 142-161.

Armitage, C. J., & Conner, M. (2001). Efficacy of the Theory of Planned Behavior: A Meta-Analytic Review. *British Journal of Social Psychology, 40,* 471-499.

Brewer, N. T., Weinstein, N. D., Cuite, C. L., & Herrington Jr., J. E. (2004). Risk Perceptions and Their Relation to Risk Behavior. *Annals of Behavioral Medicine, 27*(2), 125-130.

Cox, S. J., Cox, T., 1991. The structure of employee attitudes to safety: A European example. *Work & Stress*, *5*, 93-106.

Crano, W. D., & Prislin, R. (2006). Attitudes and Persuasion. *Annual Review of Psychology, 57*, 345-374.

Deery, H. A. (1999). Hazard and Risk Perception Among Novice Drivers. *Journal of Safety Research, 30*(4), 225-236.

Drinkwater, J. L., & Molesworth, B. R. C. (2010). Pilot See, Pilot Do: Examining the Predictors of Pilots' Risk Management. *Safety Science, 48*, 1445-1451.

Glasman, L. R., & Albarracín, D. (2006). Forming Attitudes That Predict Behavior: A Meta-Analysis of the Attitude-Behavior Relation. *Psychological Bulletin, 132*(5), 778-882.

Goh, J., & Wiegmann, D. A. (2001). Visual Flight Rules Flight into Instrument Meteorological Conditions: An Empirical Investigation of the Possible Causes. *The International Journal of Aviation Psychology, 11*(4), 359-379.

Hunter, D. R. (1995). *Airman Research Questionnaire: Methodology and Overall Results*. Springfield, VA: Federal Aviation Administration.

Hunter, D. R. (2003). Measuring General Aviation Pilot Judgment Using a Situational Judgment Technique. *The International Journal of Aviation Psychology, 13*(4), 373-386.

Hunter, D. R. (2005). Measurement of Hazardous Attitudes among Pilots. *The International Journal of Aviation Psychology*, *15*(1), 23-43.

Hunter, D. R. (2006). Risk Perception Among General Aviation Pilots. *The International Journal of Aviation Psychology, 16*(2), 135-144.

Lund, I., Rundmo, T. 2009. Cross-cultural comparisons of traffic safety, risk perception, attitudes and behaviour. *Safety Science, 47,* 547-553.

Molesworth, B. R. C., & Chang, B. (2009). Predicting Pilots' Risk-Taking Behavior through an Implicit Association Test. *Human Factors, 51*(6), 845-857.

Molesworth, B. R. C., Wiggins, M. W., & O'Hare, D. (2006). Improving Pilots' Risk Assessment Skills in Low-Flying Operations: The Role of Feedback and Experience. *Accident Analysis and Prevention, 38*, 954-960.

O'Hare, D., & Smitheram, T. (1995). "Pressing on" into Deteriorating Conditions: An Application of Behavioral Decision Theory to Pilot Decision Making. *International Journal of Aviation Psychology, 5*(4), 351-370.

Retting, R. A., Ulmer, R. G., Williams, A. F., 1999. Prevalence and characteristics of red light running crashes in the United States. *Accident Analysis and Prevention, 31,* 687-694.

Smith, J. R., & Terry, D. J. (2003). Attitude-Behavior Consistency: The Role of Group Norms, Attitude Accessibility, and Mode of Behavioral Decision-Making. *European Journal of Social Psychology, 33*, 591-608.

Ulleberg, P., & Rundmo, T. (2003). Personality, Attitudes and Risk Perception as Predictors of Risky Driving Behavior among Young Drivers. *Safety Science*, *41*, 427-443.